



# Do Exposures to Mobile Source Particles Damage Health?

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research  
and  
development

## Background

Every resident of the United States is exposed to particles from mobile sources, by virtue of the fact that nearly everyone travels by car, bus, or train, walks or bikes alongside roadways, or sits in their home or office alongside a busy road. Results from epidemiology studies show that exposures to traffic-related particles present substantial risks, having been linked to a variety of adverse effects including increased deaths, hospital admissions, and cardiac and respiratory effects.

In order to provide biological plausibility to these epidemiology studies, as well as understand how PM derived from mobile sources may cause adverse health effects, ORD has used a multi-disciplinary approach to correlate health effects with exposure to mobile source particles.

Two examples of this approach are described in this poster. The St. Louis Cardiovascular Health and Mobile Source (St. Louis Bus) and the Car-related Occupational PM and Air Toxics Exposure to Patrolmen (COPP) studies are comprehensive studies that combine naturally enhanced mobile source exposures with detailed exposure and health measurements. Through this design, these studies were able to examine the specific impacts of mobile source pollutants on:

- Autonomic function as assessed by HRV
- Pulmonary inflammation as assessed by exhaled nitric oxide
- Systemic inflammation and vascular outcomes as assessed using blood markers

Observations from these studies are being used to identify biological pathways by which mobile source particles impact health, lending credibility to findings from these and other epidemiological studies.

*Additional mobile sources research is shown in the posters presented by Sioutas and Froines.*

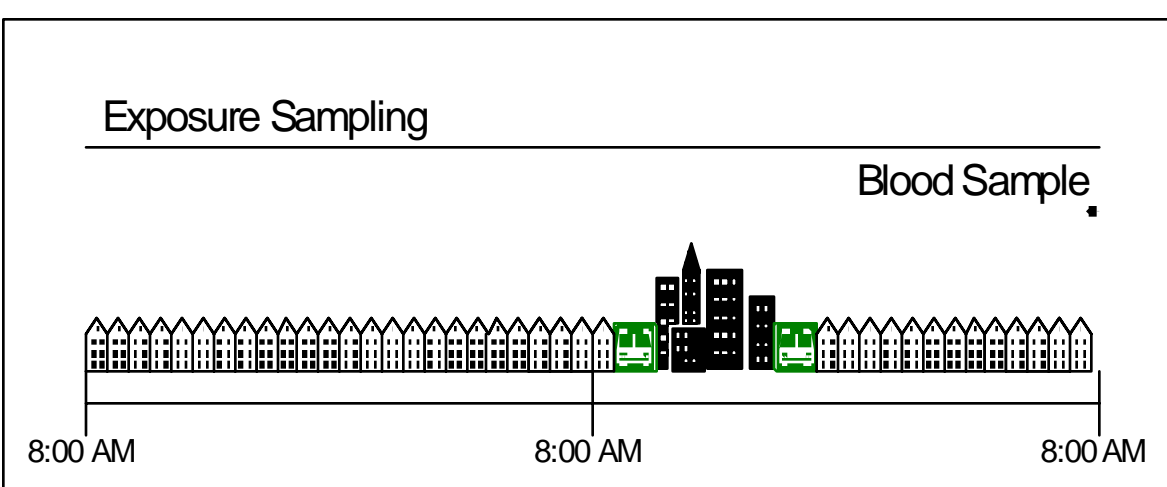
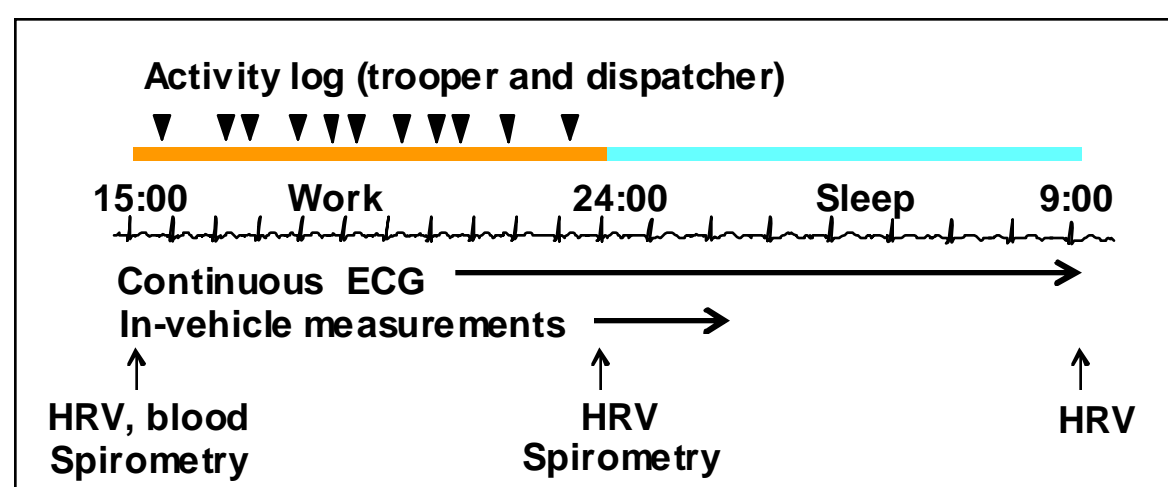
## Study Design

### COPPS

- **Cohort:** Nine male, healthy NC Highway Patrol troopers
- **Duration:** Four consecutive evening (3pm-12am) shifts; six-weeks, summer, fall 2001
- **Health:** Continuous EKG recordings, activity logs; pre- and post-shift spirometry, pre-shift, one post-shift blood draw
- **Pollution:** Inside patrol cars, along roadside, outdoors at fixed community monitors

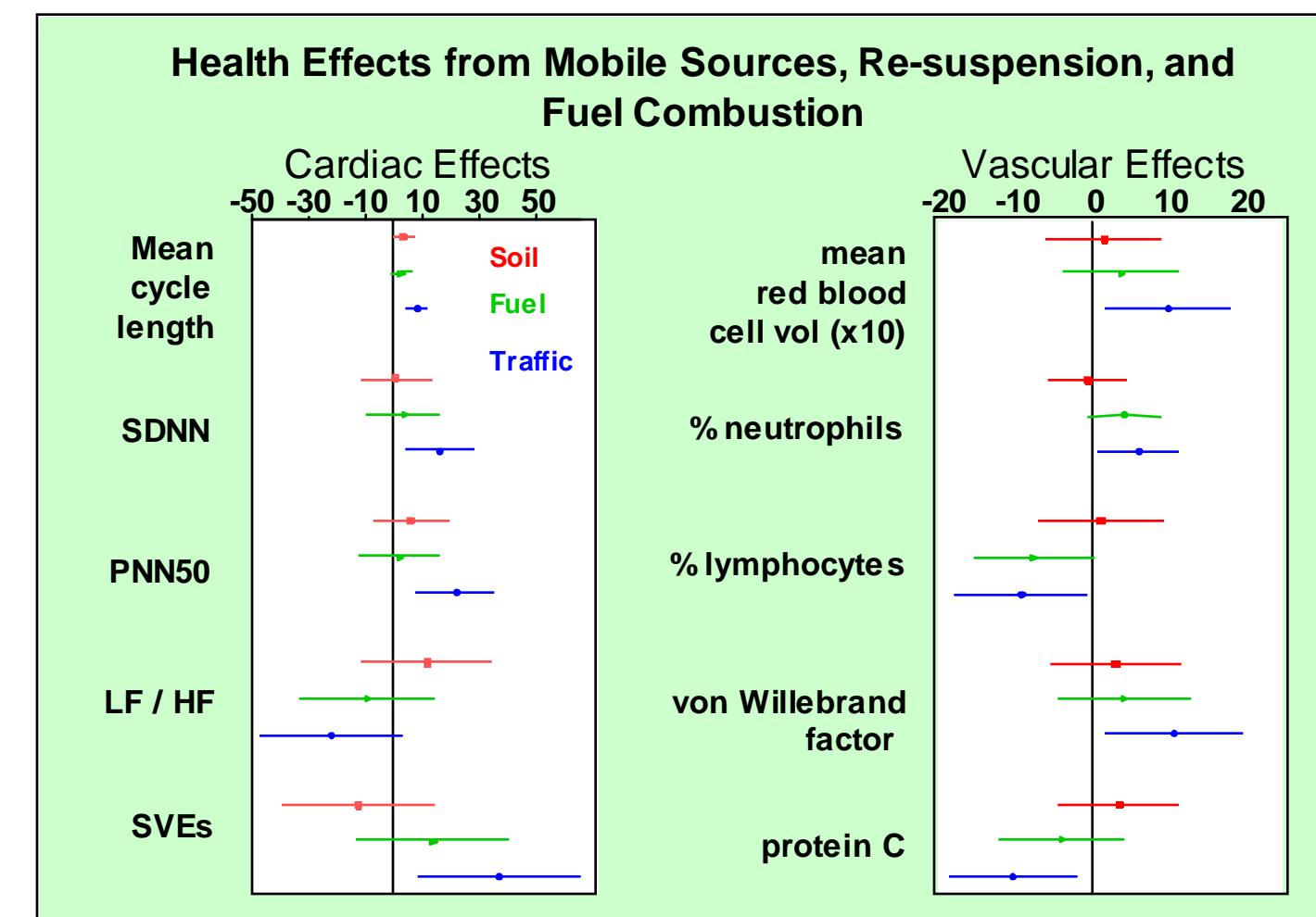
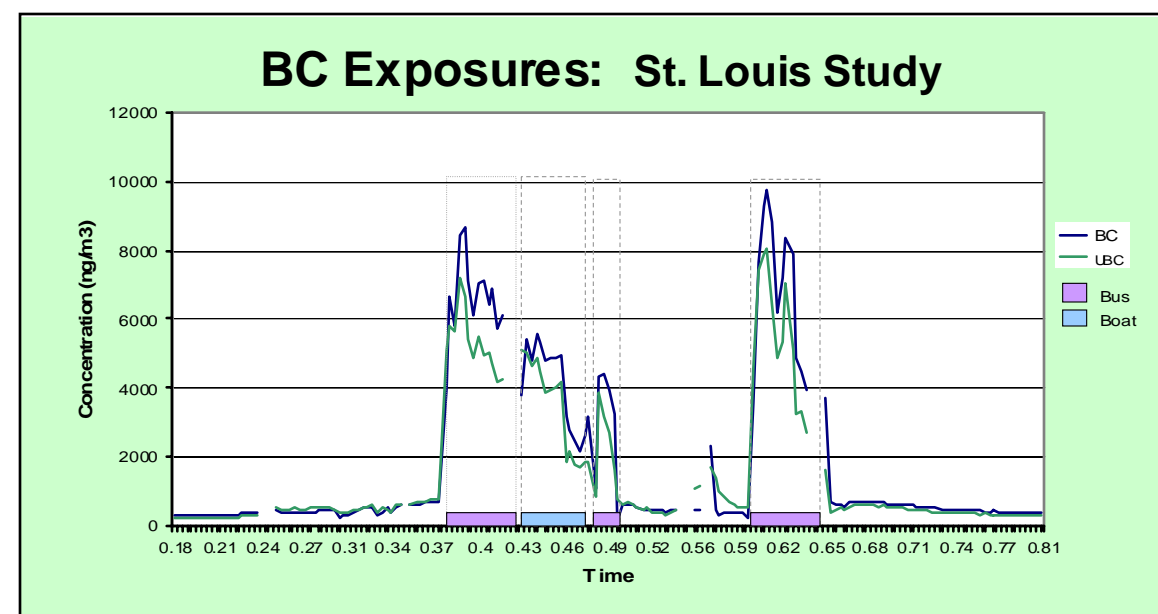
### St. Louis Bus Study

- **Cohort:** 44 non-smoking seniors living in suburban St. Louis
- **Duration:** Four trips, with 2 hrs of highway driving; March-July 2002
- **Health:** Continuous EKG recordings, activity logs; pre- and post-trip exhaled NO post-trip blood draws
- **Pollution:** Continuous personal exposure and ambient measurements



## Findings

- **Time spent in motor vehicles increases exposure to particles.**
  - As illustrated in the St. Louis study, exposures to black carbon and other traffic-related particles increased dramatically when participants were on the diesel-powered bus or boat.
  - Mobile source pollutant exposures tend to be uncorrelated with corresponding ambient concentrations, especially during motor vehicle travel
- **Particles from mobile sources are associated with changes in cardiac and vascular function.**
  - As shown in COPPS, mobile source PM may lead to pro-inflammatory, pro-thrombotic effects in healthy young men.
  - Changes in HRV suggest an increased parasympathetic input to the heart.
  - Stop and go traffic conditions induce strongest effects.



- **Risks from mobile source particles are best estimated using personal exposures**

- As illustrated in the St. Louis study, the effects of ambient PM<sub>2.5</sub> on systemic inflammation are less than those of micro-environmental levels.
- Observed lower risks may be due to increased exposure error with ambient data, which do not account for personal activities.
- Results indicate the importance of individual-specific exposure measurements for mobile source particles.

Percent Change in CRP, IL-6, and WBC Per 10 µg/m <sup>3</sup> PM <sub>2.5</sub> : by Susceptibility			
	CRP (mg/dL)	IL6 (pg/mL)	WBC (k/cumm)
<b>Ambient PM<sub>2.5</sub></b>			
All	2.5 (-14, 23)	-6.1 (-16, 5.5)	0.11 (-4.3, 4.7)
Elevated Metabolic Risk <sup>a</sup>	<b>86 (15, 201)</b>	24 (-8.3, 67)	-4.6 (-15, 6.7)
<b>Microenvironmental PM<sub>2.5</sub></b>			
All	4.0 (-24, 43)	-4.8 (-22, 17)	-3.1 (-11, 4.9)
Elevated Metabolic Risk	<b>147 (38, 342)</b>	25 (-15, 86)	-7.8 (-21, 7.1)

Bold values indicate statistical significance at the 95% confidence limit.  
<sup>a</sup>Elevated metabolic risk include individuals w/ a systolic BP ≥ 140 or diastolic BP ≥ 90 or taking hypertensive medications, a BMI ≥ 30, and diabetic.  
<sup>b</sup>Models were adjusted for sex, obesity, diabetes, smoking history, indoor, outdoor apparent temperature, mold, pollen, vitamin use, trip, and hour of blood draw.



## Summary and Significance

### Mobile Source Exposures

- Travel in motor vehicles has been shown to increase exposures to pollutants emitted from mobile sources dramatically.
- Mobile source exposures can vary substantially over time and space, diminishing the ability of traditional stationary ambient monitoring site measurements to reflect mobile source exposures,
- Alternate methods to assess mobile source exposures are needed in epidemiological studies.

### Mobile Source Health Effects

- Recent studies have shown that exposures to mobile source particles impact several biological pathways linked to cardiac disease, including autonomic function, pulmonary and systemic inflammation, and vascular function.
- Findings of autonomic, inflammatory, and vascular effects support earlier findings linking mobile source particle exposures to increased mortality and hospital admissions, particularly for cardiovascular-related conditions.
- Gases emitted by mobile sources, such as nitrogen dioxide, have also been linked to autonomic, inflammatory and vascular effects.
- The risks presented by mobile source pollutants can be assessed most accurately when exposures to these pollutants are measured directly.

### Overall Impact

**Exposure to mobile source particles presents substantial cardiovascular health risks; it is not known which specific components (or gaseous co-pollutants) are responsible for the observed effects.**

## Future Directions

Continued innovative and inter-disciplinary research is needed to examine the health risks posed by mobile source particles. These examinations will be critical to our ability to identify biological pathways important to mobile source particle toxicity and to relate the risks posed by mobile source particles to other pollution sources.

Future research should use new techniques to examine mobile source health effects, including:

- GIS spatial techniques to estimate exposures
- mobile source tracer measurements to enhance characterization of mobile source exposures
- direct exposures to mobile source particle emissions to allow effect of mobile source particles to be examined independently from other pollutants
- genotyping to examine gene-environment interactions and heterogeneity in response
- structural equation models to confirm biological pathways

This poster does not necessarily reflect EPA policy. Mention of trade names or commercial products does not constitute endorsement or recommendation for use.

# Source to Health Outcome